Rehabilitation and return-to-sport after anterior cruciate ligament injury and reconstruction: Exploring physical therapists' approaches in Argentina

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TITLE PAGE

Rehabilitation and Return-to-Sport Following Anterior Cruciate Ligament Injury and Reconstruction: Exploring Physical Therapists' Approaches in Argentina

ABSTRACT

Objectives: To investigate the current clinical practice regarding pre- and post-surgical rehabilitation and return to sport (RTS) criteria following anterior cruciate ligament reconstruction (ACLR).

Design: Cross-sectional design. Online survey.

Setting: Survey platform.

Participants: Argentinian physical therapists (PTs).

Outcome Measures: The survey consisted of a combination of 39 open- and closed-ended questions, divided across 3 sections: (1) demographic and professional information, (2) clinical practice and rehabilitation strategies, and (3) return-to-running (RTR) and RTS.

Results: A total of 619 PTs completed the survey. Considerable variability was observed in preoperative rehabilitation, criteria used for rehabilitation progression and RTS decision-making criteria used by PTs. From the total surveyed, 336 (54.3%) carried out RTS assessment in their clinical practice. Most of PTs (53.3%) use visual estimation to assess knee range of motion. Only 20% of the PTs reported incorporating patient-reported outcome measures in their decision-making. From PTs who use strength assessment as a criterion of RTS (68.8%), 16.6% extrapolate this from jump tests and 15.3% use manual muscle testing. Less than the 50% of the PTs recommended nine months or more to allow patients to RTS.

Conclusions: Current rehabilitation practices of Argentinian PTs following ACLR are largely variable and not aligned with current evidence and scientific guidelines. To achieve better rehabilitation and RTS practices better knowledge dissemination and implementation are required.

KEY WORDS

Anterior cruciate ligament reconstruction; Rehabilitation; Physical therapy; Return to sport; Return to running.

1. Introduction

An anterior cruciate ligament (ACL) rupture is a severe injury in high-demand sports involving landing, turning, and pivoting, such as football, basketball, and handball (Grindem et al., 2016). The incidence of ACL ruptures is high, with 68.6 cases per 100,000 person-years reported in countries like the United States and Denmark (Griffin et al., 2006; Lind et al., 2012). ACL reconstruction (ACLR) is the primary means of restoring structural stability and facilitating the return to sports (RTS) (King et al., 2020). Achieving successful outcomes after ACLR involves careful consideration of surgical aspects pertaining to rehabilitation. These considerations include the choice of surgical technique, selection of appropriate graft type, methods of graft fixation, and addressing any concomitant injuries (Li, 2022). Nevertheless, a high rate of secondary ACL injuries and recurrences has been reported, especially in young athletes (Wiggins et al., 2016).

One of the main goals of ACLR is to enable patients to RTS successfully. Several preoperative, operative, and postoperative factors can influence a patient's ability to RTS and risk of re-injury (Aquino et al., 2021; Irarrázaval et al., 2016). Preoperative rehabilitation is essential to address post-injury impairments and prepare optimally for surgery (Ficek et al., 2022). Postoperative rehabilitation plays a critical role in maximizing the chances of successfully RTS and reduce the risk of secondary injuries (Rodriguez-Merchan & Valentino, 2022). Current state-of-the art- rehabilitation practices include a combination of testing and training across the ACLR rehabilitation continuum (Dingenen & Gokeler, 2017).

Despite the available evidence on rehabilitation and RTS criteria (Kotsifaki et al., 2023; Burgi et al., 2019; Grindem et al., 2016; Kyritsis et al., 2016), recent survey-type studies have shown considerable variability among physical therapists (PTs) regarding rehabilitation practices applied before and after ACLR (Dingenen et al., 2021; Ebert et

al., 2019; Fausett et al., 2022; Greenberg et al., 2018; Korakakis et al., 2021; Pulver et al., 2023). In Brazil, only 6.4% of physical therapists use the criteria recommended for RTS after ACLR (Aquino et al., 2021). Greenberg et al. (2018) reported a high degree of heterogeneity in rehabilitation progression in the United States, whereas Ebert et al. (2019) obtained similar results in Australia.

While surveys conducted around the world offer valuable insights into the management strategies employed by PTs, it remains essential to evaluate rehabilitation strategies in other countries. Cultural differences, disparities in healthcare systems, and educational variations can significantly influence the duration, quality and content of rehabilitation (Grindem et al., 2018). In Argentina, significant barriers to access information further complicate professional development. This is particularly due to linguistic and socioeconomic differences. The predominant use of Spanish in Argentina poses a language barrier that not only limits access to scientific literature, including recent clinical guidelines, but also exacerbates economic challenges. These economic hurdles can impede access to essential resources for professional development, such as participation in conferences, specialized courses, and the acquisition of technology. Therefore, this study aims to investigate the current clinical practice regarding pre- and post-surgical rehabilitation and RTS criteria following ACLR among Argentinian PTs. We hypothesize that there will be a high variability in rehabilitation practices and RTS decision-making criteria, and a wide disparity between clinical practice and the current scientific evidence in ACLR rehabilitation as occurred in other countries (Alshehri et al., 2024; Dingenen et al., 2021; Ebert et al., 2019; Fausett et al., 2022; Greenberg et al., 2018; Korakakis et al., 2021; Pulver et al., 2023).

2. Methods

2.1. Study design.

By using a cross-sectional design, a survey was developed using Survey Monkey™. PTs members of the Argentinian Sport Physical Therapists Association (AKD) were recruited through email invitations with the link to the online survey. We then aimed to include the whole Physical Therapy community, sending electronically through emails databases from colleagues from universities, clinics, sport clinics and using authors social networks to promote to PTs and sports PTs, as well as distributed through mobile phone messaging sports physical therapy groups, where sports PTs share research, cases, and information. The survey was available for completion from June 30, 2023, and September 30, 2023.

2.2. Survey design and piloting.

To develop the survey, three PTs with over ten years of experience in managing ACL injuries generated an item pool of 45 questions based on the literature review, their professional experience and relevant surveys from other countries (Dingenen et al., 2021; Ebert et al., 2019; Fausett et al., 2022; Greenberg et al., 2018; Korakakis et al., 2021). Three PTs with more than 6 years of experience evaluated the items based on their content and eliminated less relevant ones. The remaining 39 questions were tested using a structured content analytic method and reviewed by three sports PTs, a sports psychologist, and a sociologist to control and debug any errors or inconsistencies. The survey was divided into three sections (Supplementary Material 1). The first section gathered demographic and professional information, such as age, gender, location, years of experience, education, specialization and if they were membership of the Sport Physical Therapy Association (Question 1-8). The second section focused on clinical

practice and rehabilitation strategies, covering the clinical practice environment, patient activity levels and volume, postoperative times, rehabilitation frequency, beliefs about pre- and postoperative care, treatments used, open kinetic chain exercises, rehabilitation progression criteria, Range of motion (ROM) and patient reported outcome measures (PROMs) (Question 9 to 22). The third section explored the criteria for RTR and RTS, training methods and physical assessments (Question 23 to 39). In this section, "lower limb functional capacity" was used to englobe all types of jumps and dynamic balance. To ensure feasibility, readability, and face validity, 8 PTs with more than 15 years of experience on knee injuries and musculoskeletal disorders (4 males and 4 females, aged between 26 and 40 years) piloted the survey (Tsang et al., 2017). In some questions respondents could choose more than one answer. The survey length and completion time were positively rated by 10 respondents, while all respondents positively rated the comprehensibility, type and ease of administration. Some formatting changes were made to enhance readability.

2.3 Procedures and participants.

Participants for the survey were restricted to Argentinian PTs who has studied in Argentina and work or have been working in Argentina with patients undergoing ACLR surgery at the time of responding. The survey required PTs to answer questions based on their current practice. The survey was designed to be anonymous, a fact clearly indicated in the information section. The study was conducted according to the ethical standards outlined in the Declaration of Helsinki, and all participants provided informed consent before anonymously completing the online survey. Completing this online survey took approximately 17 minutes.

2.4 Data Analysis

An analysis was carried out based on the responses that PTs provided through an online survey. The responses were exported to an Excel file and all analyses were conducted from there. Continuous numerical variables that assumed a normal distribution were reported as mean and standard deviation (SD). Otherwise, they were reported as median and interquartile range (IQR). To assess the normality of the sample, the Shapiro-Wilk statistical test and graphical evaluation using histograms and box plots were used. Categorical variables were reported as number of occurrences and percentages (%). For closed-ended questions (Question 1-27, 38) the proportion of respondents (%) who selected each response option was calculated. For open-ended questions, the responses were grouped according to how they referred to each topic and grouped according to similarity. The proportions were also calculated. The R software version 4.2.1 was used for all analyses.

3. Results

A total of 619 PTs completed the survey. The respondents had a mean age of 36.51 ± 8.96 years (median 35 years IQR [29; 41]). The demographic characteristics of the respondents are summarized in Table 1.

Three hundred and eighteen PTs' (51.4%) work with 6 to 20 postoperative ACLR patients per year (Question 9), 220 (35.5%) work with 1 to 5 patients, 68 (11.0%) work with 21 to 50 patients, and 13 PTs (2.1%) reported working with more than 50 patients with ACLR annually. Four hundred ninety-nine (79.3%) PTs work in private clinics, 70 (11.3%) in clubs or federations, 46 (7.4%) in hospitals, while 12 (1.9%) do so in another environment. Three hundred and twenty-two PTs (52%) mainly work with amateur athletes (nonprofessional athletes with regular competitions), 230 (37.2%) work with

recreational athletes (nonprofessional athletes without regular competitions), 52 (8.4%) work with professional athletes, and 15 (2.4%) primarily work with sedentary patients. Two hundred and eleven (34.1%) PTs responded that the patient should attend to the first appointment of rehabilitation (Question 12) "within the first 7 days after surgery", followed by 203 (32.8%) who responded "within the first 4 days after surgery"; then "after being authorized by their surgeon" with 109 (17.6%) responses, "between 1-2 weeks after surgery" with 86 (13.8%) responses, "when they feel ready to start, although I do not recommend a specific (or ideal) time" 6 (0.1%) responses and "other" 4 (0.1%) responses. The frequencies that PTs believe the patient should attend the clinic for supervised rehabilitation sessions at different stages during the postoperative period (Question 13) are shown in Figure 1. One hundred nine (17.6%) PTs do not treat ACL patients during the preoperative period. Of those PTs who do treat preoperatively, 397 (64.1%) treat 1 to 5 patients in the preoperative period per year, 106 (17.1%) treat 6 to 20 patients, 6 (0.1%) treat 21 to 50 patients, and only 1 (0.1%) treats more than 50 patients per year. Most of the PTs surveyed (93.2%) considered the period "preoperative rehabilitation" important and essential (Figure 1). In addition, the importance of rehabilitation considered by PTs at different stages of the postoperative period (Question 16) is presented in Figure 2.

Five hundred and two PTs (81.1%) considered both time and criteria when initiating open kinetic chain (OKC) exercises during patient rehabilitation. Meanwhile, 85 (13.7%) rely solely on criteria, and 32 (5.2%) rely solely on time. One hundred and seventy-one (27.6%) PTs begin with OKC exercises within the first month following surgery, 234 (37.8%) between 4 and 8 weeks, 136 (22.0%) between 8 and 12 weeks, 39 (6.3%) between 12 and 16 weeks, 14 (2.3%) after 16 weeks and 25 (4.0%) did not provide a response to the question. Figure 3 shows the most frequently used treatments used by PTs in the rehabilitation process (Question 17), the criteria that PTs consider for progressing

rehabilitation (Question 20) and which ROM assessment tools were considered (Question 21). Three hundred and seventy-one PTs (59.9%) declared that they do not use self-reported functionality and psychological readiness questionnaires (Question 22). Ten PTs (1.6%) do not know them, and 178 (28.7%) do not consider them important when authorizing a patient to return to their sports practice. Thirty-six (5.8%) use the ACL-Return to Sport after Injury (ACL-RSI), 21 (3.4%) use International Knee Document Committee (IKDC), 9 (1.4%) use the Lower Extremity Functional Scale (LEFS), 13 (2.1%) use the Tampa Scale for Kinesiophobia (TSK) and 9 (1.4%) use the Knee injury and Osteoarthritis Outcome Score (KOOS).

Of the total of the PTs surveyed, 336 (54.3%) carried out RTR and RTS assessment in their clinical practice. From this number, 14 (4.2%) answered that the person responsible of the authorization to RTS is the surgeon (question 22), 56 (16.7%) answered that it is the PT and 266 (79.2%) responded that it is a decision that should be made within a multidisciplinary approach. Figure 4 shows the RTR and RTS criteria, and the assessment tools (Questions 24, 25, 28, 30). One hundred and forty (41.7%) of the PTs allow the patient to RTR (Question 25) between the third and fourth month post-surgery, while 81 (24.1%) allow it between 4 and 5 months, 43 (12.8%) between 2 and 3 months, 36 (10.7%) do not consider the time, 26 (7.7%) after overcoming 6 months, 7 (2.1%) consider other criteria and 3 (0.9%) between the first and second month post-surgery. One hundred and fifty-four (45.8%) of the surveyed PTs allowed to RTS (Question 27) between 9 and 12 months, 146 (43.5%) between 6 and 9 months, 25 (7.4%) in less than 6 months, and 11 (3.3%) recommend their patients to RTS after one year of surgery.

Ninety-eight PTs (29.1%) do not consider knee strength as an important factor before authorizing a patient to RTS (Question 29). Among the remaining proportion of PTs, 153 (45.5%) consider a limb symmetry index (LSI) of >90% acceptable, 37 (11.0%)

>85%, 24 (7.1%) >80%, and 24 (7.1%) <75%. Similarly, out of the mentioned 336 PTs, 94 (28.0%) do not consider the limb symmetry in functional capacity as important before authorizing a patient to resume sports activities (Question 31). Meanwhile, 157 (46.7%) consider an LSI difference of >90% acceptable, 36 (10.7%) >85%, 25 (7.4%) >80%, and 24 (7.1%) <75%. Figure 5 shows training methods for physical capabilities used by PTs (Questions 32-37). Two hundred and thirty-nine (71.1%) PTs answered that they use injury prevention strategies. Those strategies are shown in Figure 5. In the option "others", PTs included specific programs such as FIFA11+ (Questions 38-39).

4. Discussion

This cross-sectional survey aimed to investigate the current clinical practice related to pre- and post-surgical rehabilitation and RTS criteria following ACLR among Argentinian PTs. The main findings were observed in preoperative rehabilitation, criteria employed for the progression of rehabilitation and RTS. In terms of strength assessment and limb asymmetry, there were discrepancies among PTs' responses.

In Argentina, the approach to physical therapy for musculoskeletal injuries is structured to prioritize referrals from traumatologists, acting as a central hub for both pre-operative interventions and ACLR. This system dictates that the commencement of treatment hinges on medical decisions, yet the collaborative teams are established, fostering interdisciplinary cooperation between doctors and PTs. Only 34.1% of the PTs begin the patient's treatment within the first 7 days after ACLR. Given the importance of early control of swelling, patellar mobility, quadriceps activation, near-normal ambulation, as well as restoration of optimal knee ROM (Adams et al., 2012; Buckthorpe et al., 2023; Wilk & Arrigo, 2017) an immediate start to the ambulatory rehabilitation process within the first week is imperative. A recent multidisciplinary consensus also

recommended a prompt start of rehabilitation after ACLR, although an optimal start time has not yet been determined (R. Kotsifaki, Korakakis, et al., 2023).

Most Argentinian PTs (93.2%) believe that preoperative rehabilitation is important or essential. This is in line with current evidence supporting the positive effect of preoperative rehabilitation on postoperative outcomes (R. Kotsifaki, Korakakis, et al., 2023). Despite this belief, 64.1% only perform 1 to 5 preoperative treatments per year. In surveys conducted in New Zealand (Fausett et al., 2022) and Australia (Ebert et al., 2019), almost all PTs consider preoperative rehabilitation important. However, these studies did not investigate the percentage of PTs who perform preoperative rehabilitation. While preoperative rehabilitation is not routinely prescribed by orthopedic surgeons in many countries (Grindem et al., 2012), it's plausible that the lack of data in Argentina may be due to a shortage of referrals or access to rehabilitation services. A high percentage (59.9%) of PTs stated that postoperative rehabilitation is essential within the first 6 months after ACLR, and even after 6 months, 34.2% of respondents still consider it essential.

The ROM assessment is an essential component of clinical practice and is used to evaluate deficits and the effects of rehabilitation processes (Shelbourne & Klotz, 2006). The current recommendations sustain that achieving extension in the first rehabilitation stage is a key component of success (R. Kotsifaki, Korakakis, et al., 2023). In this sense, 74.3% of the PTs indicated the use of ROM assessment as a criterion for rehabilitation progression. Surprisingly, 53.3% of PTs use visual estimation as their primary tool. However, visual estimations have a large measurement error and low inter- and intra-observer reliability (Watkins et al., 1991). On the other hand, 41.5 % of the PTs use mobile applications for ROM assessments, which have been shown to be a useful, viable and easily accessible tool in the clinical practice (Milanese et al., 2014). In this sense,

Mehta et. al (2017), showed excellent reliability when assessing knee flexion and extension ROM (ICC of 0.97 and 0.94, respectively) with mobile applications (Mehta et al., 2017). Previous studies evaluating PTs perspectives conducted in Australia and New Zealand report that 70.0% choose ROM assessment as a criterion for RTS. Similar numbers were found in Brazil (65.3%), the United States (61.9%) and Greece (51.1%)(Aquino et al., 2021; Greenberg et al., 2018; Korakakis et al., 2021). However, in this study only 26.7% of PTs use ROM assessment, which is alarming given that restoring optimal knee ROM in extension and flexion is crucial for RTR and RTS (R. Kotsifaki, Korakakis, et al., 2023).

Reaching the milestones of RTR is crucial, running is a fundamental activity for the rest of the rehabilitation. When the person is not adequately physically and psychologically prepared, this could lead to pain or other symptoms. The criteria for RTR are poorly described in the literature. A scoping review summarized that time was the most frequently reported criterion for RTR and fewer than one in five studies reported clinical, strength or performance-based criteria for RTR (Rambaud et al., 2018). An approach combining the assessment of goal-based criteria with time-based criteria is a suggested to be reasonable approach for RTR after ACLR (Rambaud et al., 2018). In this survey study, one hundred and forty respondents from 336 (41.7%) allow the patient to RTR between the third- and fourth-month post-surgery which is in line with the later review results. In similar studies, conducted in other countries, PTs considered time as a RTR criteria, for instance Flemish PTs (28.7%) or Greek PTs (54.9%). However, a recent clinical practice guideline on rehabilitation after ACLR suggested that patients must achieve key metrics such as 95% knee flexion ROM, full extension ROM, no effusion/trace of effusion, limb symmetry index (LSI) >80% for quadriceps strength, LSI>80% eccentric impulse during countermovement jumps and pain-free aqua jogging

or Alter-G running (R. Kotsifaki, Korakakis, et al., 2023). In this sense, time from surgery should not be considered as a RTR criterion. In line with the literature, Pulver et. al (2023) reported that PTs considered the time criterion less important than quality of neuromuscular control, pain, effusion or strength. While a significant percentage of Argentinian PTs (40.1%) base their decisions on time criteria, there exists a notable divergence between evidence-based practices and clinical approaches. To bridge this gap, educational initiatives should be introduced to facilitate a shift in decision-making related to RTR protocols. However, this study revealed that 39.3% and 46.4% PTs use strength and jump testing respectively. In this sense, the survey didn´t allow PTs to choose which types of jumps (horizontal or vertical) they considered as criteria as well were done in similar studies (Pulver et al., 2023). In terms of strength assessments, fewer than 22% of Argentinian physical therapists utilize objective measures, which deviates from current guidelines. This underscores a critical need for Argentinian PTs to incorporate objective criteria into their decision-making process for allowing patients to resume running.

One out of four (26%) Argentinian PTs reported using a single hop jump test to evaluate lower extremity functional capacity for RTS. Horizontal jump tests are commonly used in the clinical setting, as they are relatively easy to administer and produce valid and reliable results (Reinke et al., 2011). A battery of jump tests should be used when considering a RTS after ACLR and enhanced jump performance could be associated with better outcomes for patients (Ardern et al., 2016; Van Melick et al., 2016; Kyritsis et al., 2016). However, according to Kotsifaki et al., knee performance is better assessed during landing and not during propulsion, particularly on the Single Hop Jump for Distance (SHJD) (Forelli et al., 2023; A. Kotsifaki et al., 2021) and Triple Hop Jump for Distance (A. Kotsifaki, Van Rossom, et al., 2022). These findings call into question if it is important to only consider the horizontal distance during horizontal jumps. A

movement quality assessment during jump tests is recommended (Davies et al., 2020), using video cameras positioned in the frontal and sagittal plane. This has been shown to provide a practically viable option for clinicians, whereby the data captured can be exported and analyzed using freely available software (Welling et al., 2018). Recently, the SHJD - Landing Error Scoring System (LESS) was developed to assess the landing quality (Measson et al., 2022). It is noteworthy that 5.5% of Argentinian PTs in this study reported not using a battery of jump tests. Only 29.6% of all PTs use vertical jumps despite evidence showing that these jump types can more accurately identify asymmetries between limbs compared to horizontal jumps (Kotsifaki et al., 2022). Meeting RTS criteria using quality measures is associated with a lower ACL injury rate (O'Malley et al., 2018). Therefore, it is imperative to emphasize that functional evaluation should include both quantitative and qualitative measures (Wilk & Arrigo, 2017). In previous studies (Ebert et al., 2019; Fausett et al., 2022; Greenberg et al., 2018; Korakakis et al., 2021), "lower limb functional capacity" (all types of jumps and dynamic balance) was one of the most chosen criterion for RTS among PTs, reflecting that in some way PTs address functional abilities after ACLR. However, since the tests chosen by worldwide PTs are so diverse, it could be questioned whether the most optimal tests are being used as the latest research suggests (R. Kotsifaki, Sideris, et al., 2023). On the other hand, it could be possible that PTs use specific tests that they consider important for the sport in which the patients are involved. This suggests that the wide variety of tests considered by practitioners to decide when the person is ready for RTS might reflect an individualization and not always an underuse of the most optimal tests.

Interestingly, approximately one out of three (29.2%) Argentinian PTs don't use strength measures as a criterion to RTS while in similar surveys conducted in the United States, New Zealand and Australia PTs gave greater importance (91.6%, 90.0%, 87.0%

respectively) to this perspective (Ebert et al., 2019; Fausett et al., 2022a; E. M. Greenberg et al., 2018). In this study, of the total of PTs who use strength measures as a criterion of RTS, 16.6% extrapolate strength from jump tests, 15.3% use manual muscle testing and 15.7% use handheld dynamometry (HHD). The HHD presented excellent test–retest reliability for measuring the femoral quadriceps strength in patients with ACLR (ICC = 0.98, 95% CI 0.98–0.99) (Leão Almeida et al., 2019). The HHD presented moderate to good validity with the isokinetic dynamometer to evaluate the peak torque of the femoral quadriceps in patients with ACLR ($r = 0.62$, $p < 0.001$) (Leão Almeida et al., 2019). However, HHD has its limitations to measure quadriceps strength (Norris et al., 2024). Only 5.7% Argentinian PTs use Isokinetic assessment of knee strength, although it remains the gold standard (Cvjetkovic et al., 2015), probably this low number is due to its cost and availability in the country. Manual muscle testing is a commonly employed method among PTs, with 15.3% of Argentinian practitioners in our study utilizing it as a criterion for RTS decision. However, it is crucial to acknowledge the limitations of manual muscle testing, as it has been associated with low validity in assessing muscle strength, particularly when compared to more objective measures such as isokinetic assessments (Bohannon et al., 2005). The subjectivity inherent in manual muscle testing may lead to variability in results and potentially compromise the accuracy of decisions regarding an athlete's readiness to RTS. According to Bohannon (2005), based on calculated negative predictive values, the likelihood of manual muscle testing confirming differences in strength identified through dynamometry between sides was never greater than 78%. Furthermore, its likelihood of confirming strength deficits determined by dynamometry never reached 50%. Surprisingly, 16.6% of PTs extrapolate strength from jump tests, however jump tests do not strongly correlate with objective measures of knee muscle strength, leading to potential overestimation of knee muscle strength (Sekiya et

al., 1998). In general, the methods used by most PTs to evaluate knee muscle strength after ACLR are worrisome since these approaches could limit the ability to effectively measure isolated muscle strength. An overestimation of knee muscle strength by these methods could lead to insufficient rehabilitation stimulus to promote muscle strength, prescription of rehabilitation exercises that overvalue the patient's true functional capacity or premature return to pre-injury activities (Beischer et al., 2019) Given the positive relationship between knee strength and patient outcomes after surgery (Asaeda et al.,2018), there seems to be considerable room for improvement in the assessment of knee muscle strength by Argentinian PTs.

In this study over 70% of PTs considered the amount of time after ACLR as a criterion for RTS, although 38% of them responded that the athlete could be ready before the ninth month, demonstrating the lack of adherence by Argentinian PTs to the latest recommendations (R. Kotsifaki, Korakakis, et al., 2023). In this sense, previous survey studies, most PTs recommended that the necessary time away from sports should be greater than nine months (Aquino et al., 2021; Dingenen et al., 2021; Ebert et al., 2019; Fausett et al., 2022; Greenberg et al., 2018; Korakakis et al., 2021; Pulver et al., 2023). Historically, a recommended RTS parameter was set at six months (Barber-Westin & Noyes, 2011a, 2011b; van Grinsven et al., 2010). However, according to recent studies (Beischer et al., 2019; Grindem et al., 2016), RTS before nine months after ACLR is associated with a higher risk of re-injury. In addition, a systematic review (Claes et al., 2011) about the ligamentization process of the ACLR showed that this biological process continued for more than six months, reinforcing the findings reported in previous studies (Grindem et al., 2016; Kyritsis et al., 2016).

Self-reported outcomes measures are critical for understanding patients functional and psychological progression across the rehabilitation continuum (Van Melick et al., 2016)

(Truong et al., 2020). In this study, less than 20% of PTs use PROMS associated with aspects of ACLR rehabilitation progression and RTS. The consideration of self-reported functional status and psychological tests were overlooked by over 85% of Argentinian PTs, which suggests a substantial gap between the current practices most of Argentinian PTs and the current scientific evidence (R. Kotsifaki, Korakakis, et al., 2023; Van Melick et al., 2016). Results of previous surveys conducted in many countries (Aquino et al., 2021; Dingenen et al., 2021; Greenberg et al., 2018; Pulver et al., 2023) also reflect that psychological, social and contextual factors are hardly adopted within current rehabilitation approaches. Hence, it is imperative to encourage greater participation of PTs in updating themself as much as they could according to the current guidelines. Additionally, fostering enhanced collaboration between lecturers, researchers and clinicians is paramount for the dissemination and implementation of novel research findings within clinical practice trough PTs organizations. Such modifications stand to benefit physiotherapists by enhancing the quality of rehabilitation services, while patients would reap the rewards of improved care standards.

Study limitations:

Firstly, the survey duration could have been a barrier to answering the survey. Another limitation was that the survey design and the way it was disseminated may have created a potential for response bias, with many factors not considered that could have contributed to variation in treatment approaches. Selection bias may be present, which may overestimate the quality of rehabilitation practices or underestimate the true variability of respondents in Argentina. Only physical therapists who demonstrated interest in the subject and voluntarily participated in the survey were included. Consequently, there exists the possibility that the survey results may represent an

overestimation of rehabilitation quality. The response rate was not possible to calculate due to the dissemination method. Finally, an important limitation to consider in this study is that the survey doesn't allow PTs to response specific important options such as flexion and extension ROM measurement or if this measure was conducted actively or passively.

5. Conclusion

This study reported substantial variability in clinical practice of PTs regarding pre- and post-surgical rehabilitation and RTS criteria following ACLR. Current rehabilitation practices following ACLR in Argentina are largely not aligned with contemporary evidence and scientific guidelines. Particularly, in the use of preoperative physical therapy, ROM and strength assessment, and the criteria used for RTR and RTS. Future research should be directed at understanding the barriers faced by Argentinian PTs in implementing the findings of this research into their practice, improving the dissemination of scientific knowledge and their implementation in clinical practice.

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Table 1. Demographic characteristics (N = 619)

Characteristics	n	(%)
Sex		
Male	459	74.2
Female	160	25.8
Region		
Metropolitan area of Buenos Aires	141	22.8
Buenos Aires City	128	20.7
Litoral	122	19.7
Pampas	68	11.0
Sierras	56	9.0
Patagonia	44	7.1
Noroeste	28	4.5
Cuyo	27	4.4
Austral extreme	5	0.8
Argentinian Sport Physical Therapists Association members		
Yes	223	36.0
No	396	64.0
Years of professional experience		
< 1 year	30	4.8
1 y 3 years	96	15.5
between 3 y 5 years	82	13.2
between 5 y 10 years	146	23.6
between 10 y 20 years	168	27.1
>20 years	97	15.7
Qualifications		
BSc	342	55.3
BSc plus other diplomas & certificates	250	40.4
MSc	19	3.1
PhD	3	0.05
Specialization area		
Musculoskeletal in general	495	79.97
Only lower limbs	70	11.31
Lower limbs and others	51	8.24

Figure 1. Frequencies (N and %) which the respondents considered that the patient should attend the clinic for supervised rehabilitation at different stages after the surgery.

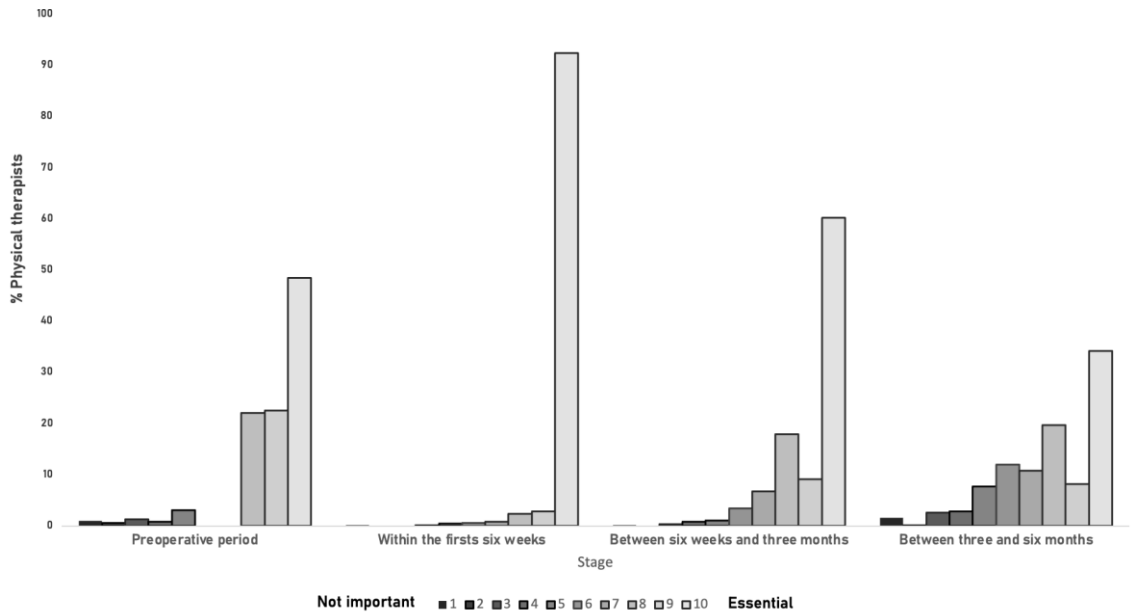


Figure 2. Frequencies of responses (N and %) related the importance of the rehabilitation process to achieve the best outcomes.

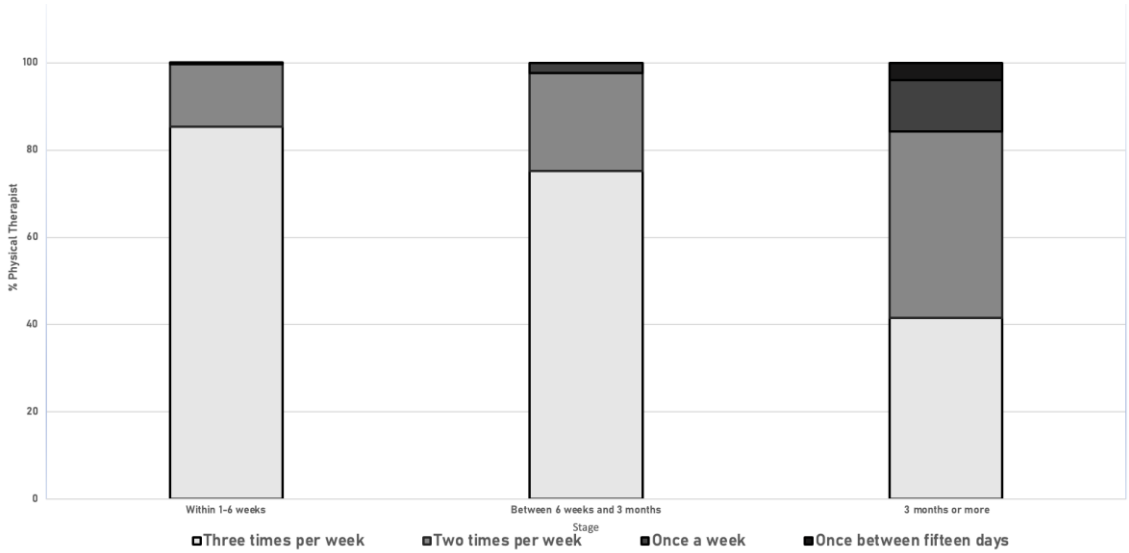
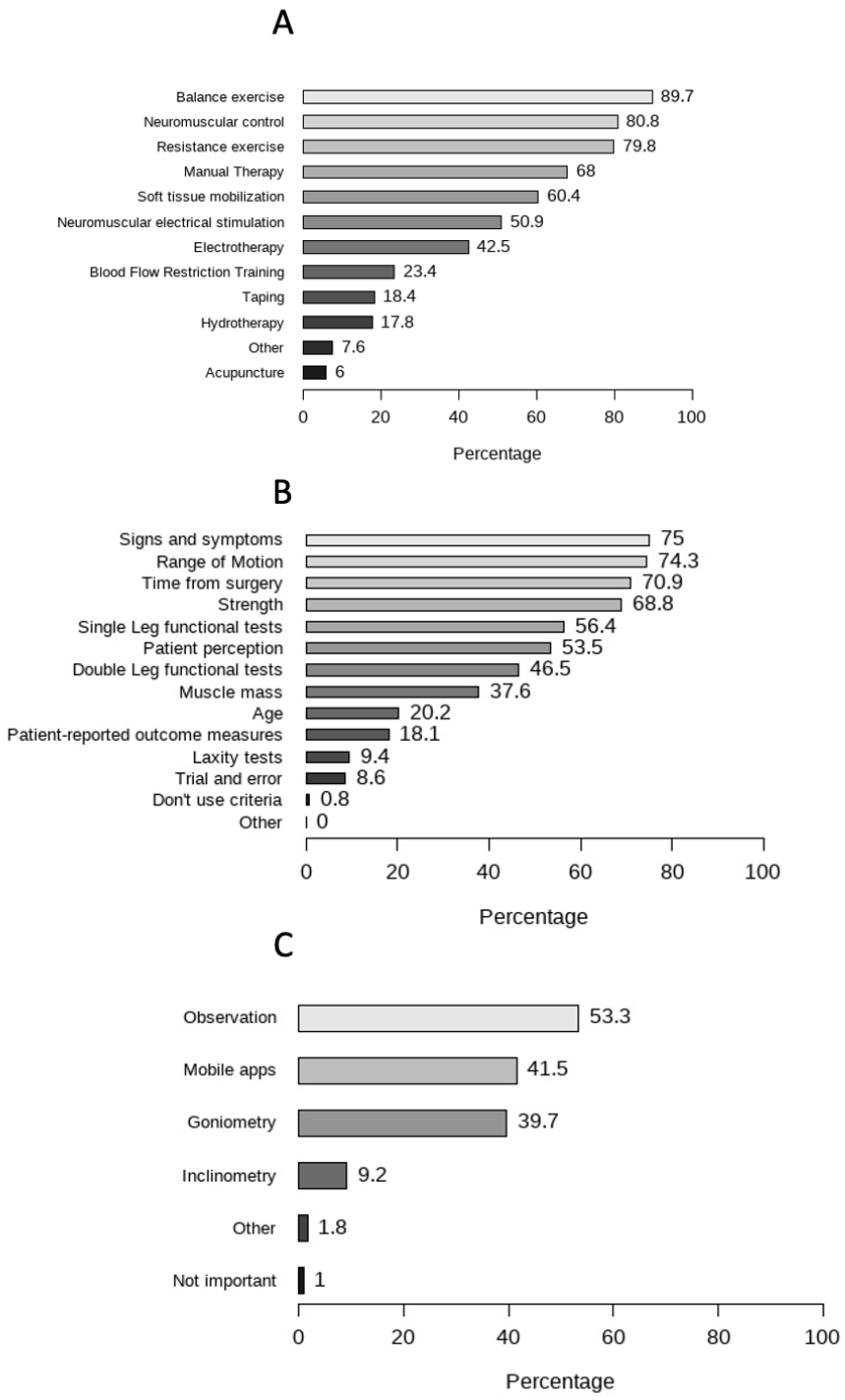
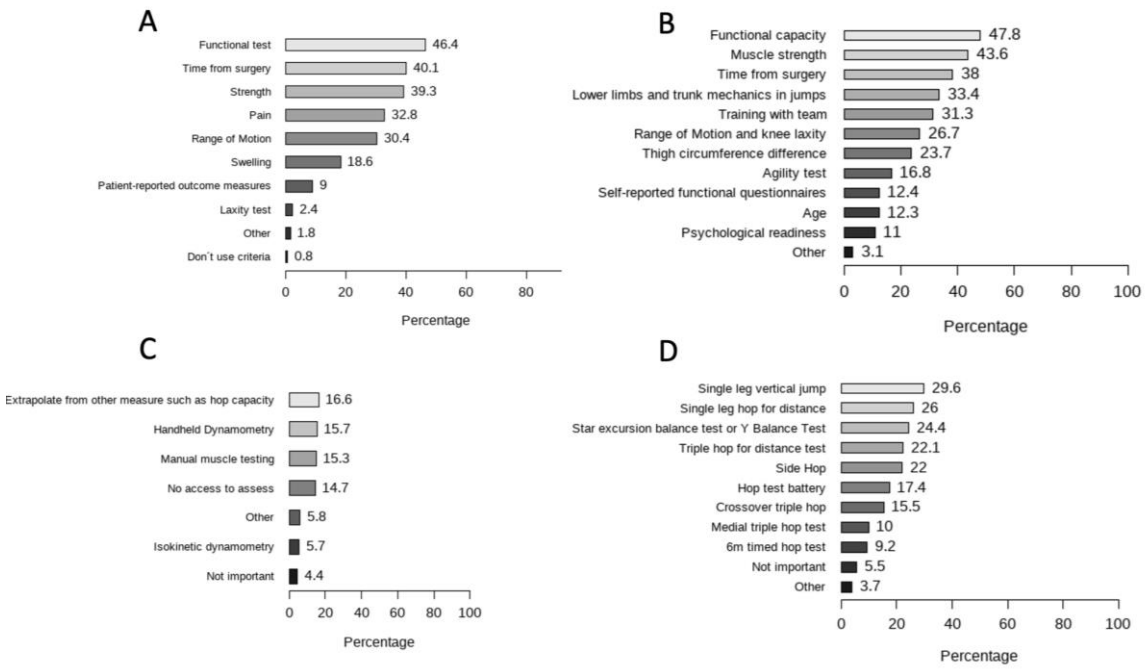


Figure 3. Responses on treatments strategies during rehabilitation, rehabilitation progression criteria and Range of Motion assessments used by Argentinian physical therapists.



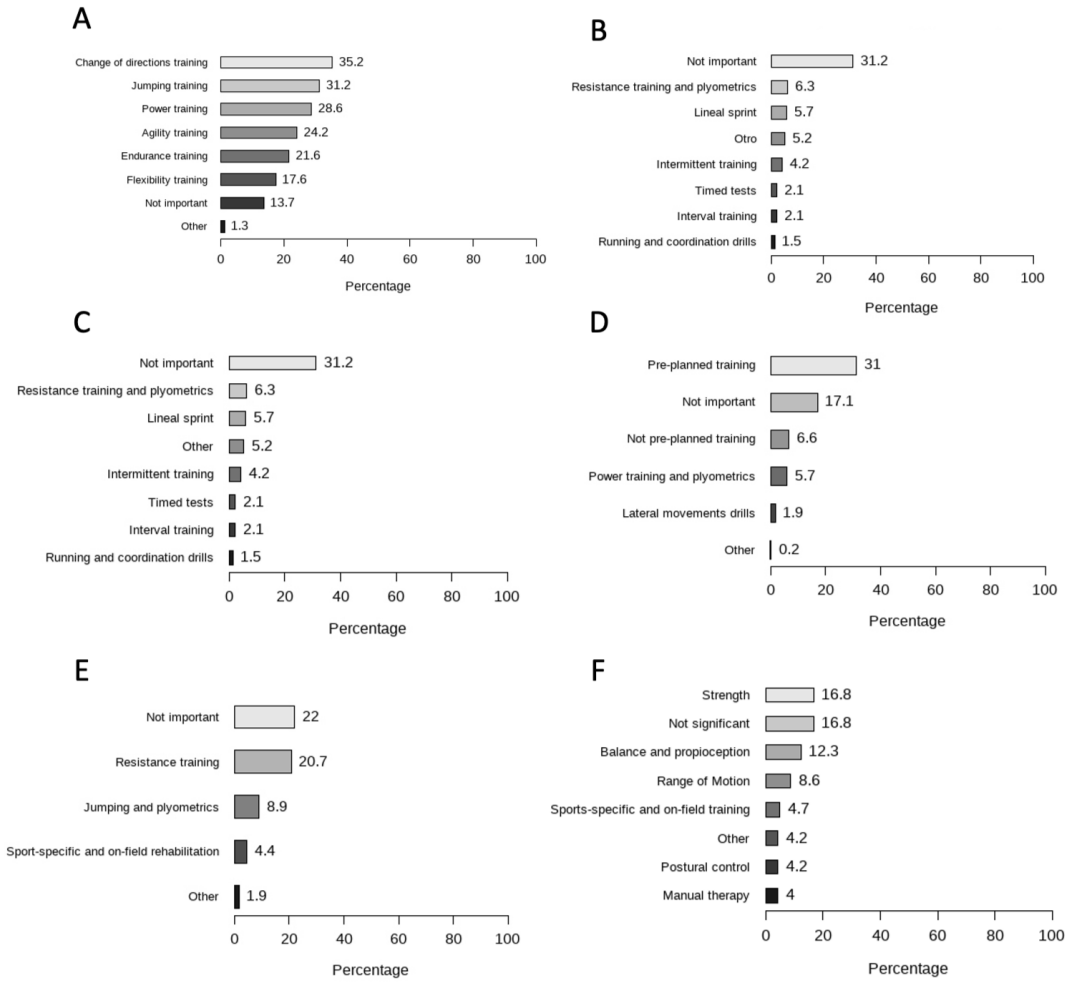
References: A: treatment strategies (Question 17); B: rehabilitation progression criteria (Question 20); C: Range of Motion assessments (Question 21).

Figure 4. Responses on RTR and RTS criteria, assessment tools used by Argentinian physical therapists.



References: A, criteria used for return to run (Question 24); B, criteria used for return to sport (Question 26); C, strength assessments (Question 28), D, lower extremity functional capacity assessments (Question 30).

Figure 5. Responses on training methods and injury prevention strategies used by Argentinian physical therapists.



References: A, physical capabilities training (Question 32); B, methods used for speed training (Question 33), C, methods used for aerobic capacity (Question 34); D, methods used for change of direction training (Question 35); E, methods used for power training (Question 37), F, methods used for flexibility training (Question 36).

15th April 2024

Reviewer 1' Comments to Author:

Thanks for the opportunity to review your manuscript. Very nice work.

Dear Reviewer,

Firstly, we would like to thank you for the time taken to review our manuscript, the positive and constructive feedback and to further consider our manuscript as a good fit for this prestigious journal. Please note that all changes made in the manuscript are highlighted in red. In addition, below each question our responses are provided in italics.

Thank you.

The authors.

Please attached my edits

Abstract:

1-In results section, please include percentage and number of participants please.

Thank you for this comment. The abstract was modified as you suggested.

2-In keywords section, I suggest you may add return to running.

Thank you for this comment. The keyword was added as you suggested.

Introduction:

3-Page 5; Line 11-15: Could you explain the surgical consideration about ACLR rehabilitation

Thank you for this comment. We added some references to support the idea. The information was added as you suggested.

Methods:

4-Page 7; Line 7: Please add PT experience please.

Thank you for this comment. This was added as you suggested.

5-Page 7, Line 22-25: Please specify if all the PTs has studied in Argentina because you can work in Argentina but studied in other country which could influence the results. I think you should explain more the inclusion and exclusion criteria.

Thank you for this comment. This was modified as you suggested.

6-Page 7; Line 24: Please modified ACL reconstruction by ACLR

Thank you for this comment. The word was modified as you suggested.

Results:

7-Page 8; Line 34: Please use ACLR and not ACL reconstruction
Thank you for this comment. The word was modified as you suggested.

8-Page 9; Line 39: Please quote any other environment please
Thank you for this comment. We cannot understand what the reviewer meant here…. Please give us a north with this suggestion…so difficult to find what is referring to.

Discussion:

9- Page 11; Line 58: What do the surgeons prescribe preoperative rehabilitation? in many countries, surgeons doesn't prescribe preoperative rehab. How is going on Argentina? This indication may influence the results.

Thank you for this comment. This was modified as you suggested adding information in discussion section.

10-Page 12: Line 15: please explain ROM. It's flexion and/or extension? Passive and or active? Because the current recommendations sustain that extension is the most important in first rehab stage.

Thank you for this comment. This was modified as you suggested adding information in the discussion. Although, we consider this as a limitation because in the survey we didn't allow PTs to differentiate between flexion/extension ROM measurement or actively and passively.

11-Page 12: Line 30: Mobile applications are using. ok. could you specify the inter and intra reliability? After you might compare to the visual assessment.

Thank you for this comment. This was added as you suggested.

12-Page 13: Lin 5-15: You should distinguish the knee performance (vertical jump and horizontal hop landing) and lower limb performance. Both are important in RTS after ACLR. Please check https://pubmed.ncbi.nlm.nih.gov/37020454/

Thank you for this comment. We intended go deeper adding some reference to support the idea. The information was added as you suggested.

13-Page 13: Line 17: Please explain what would you like to use for quality assessment?

Thank you for this comment. We intended go deeper adding some reference to support the idea. The information was added as you suggested.

14-Page 14: Line 2-5: Please clarify the validity and reliability for each assessment https://pubmed.ncbi.nlm.nih.gov/30377716/

Thank you for this comment. The values of the validity and reliability were added as you suggested.

15-Page 14: Line 17: Please provide any values for manual testing validity

Thank you for this comment. This was modified as you suggested adding information in the discussion and references.

16-Page 15: Line 22: Please use ACLR and not ACL reconstruction

Thank you for this comment. The word was modified as you suggested

17-You didn't write anything about RTR in discussion chapter. Why? May be you should write something because it's not the same than RTS. Besides, you didn't discuss around the cut-ff values for RTS or RTR which are used by the PT (LSI, PT/BW). I think it's very important to clarify because you don't only assess the strength you have to assess the strength to determine the capacity to RTR , RTS, RTP or just rehab progression.

Thank you for this comment. We intended go deeper on RTR adding valuable information from many references to support the idea. The information was added as you suggested.

Reviewer 2' Comments to Author:

Reviewer #2: Thank you for the opportunity to review this paper on Argentinian Physiotherapist knowledge of return to sport testing after ACL repair. Whilst the knowledge is specific to this region the authors have compared their findings to other regions who have completed similar studies. Therefore, this adds to the body of knowledge in this area and demonstrates more training in this key rehabilitation area needs to be done.
The paper is well written and easy to follow, the figures and tables are clear. The methods are sound and the results and discussion are meaningful.
I only have a few small areas that could be addressed.

Dear Reviewer,

Firstly, we would like to thank you for the time taken to review our manuscript, the positive and constructive feedback and to further consider our manuscript as a good fit for this prestigious journal. Please note that all changes made in the manuscript are highlighted in red. In addition, below each question our responses are provided in italics.

Thank you.

The authors.

Introduction

1-line 15 The reference to Shelbourne is quite old and could be updated.

Thank you for this comment. The reference was modified as you suggested.

Methods
2-page 6 line 5 Can the authors provide a reference for the face validity. Can I suggest either
Story, D. A., & Tait, A. R. (2019). Survey research. Anesthesiology, 130(2),

192-202. or Tsang, S., Royse, C. F., & Terkawi, A. S. (2017). Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. Saudi journal of anaesthesia, 11(Suppl 1), S80-S89.

Thank you for this comment. The reference was added as you suggested.

Results

3-Page 10 Line 19 I realise this can be tricky but is it possible to calculate the response rate from the total pool of physios? If not there need to be a statement as to why this was not possible.

Thank you for this comment. It was not possible to calculate the response rate. We don't know how many physios opened their e-mail or how many physios we finally reached with each via. We have added this as a limitation that we were not able to calculate the response rate based on the method being used to reach the physios.

Discussion

4-page 14 Line 27 Watklns et al., 1991). I think this is a typo in the reference and should be MA Watkins

Thank you for this comment. The reference was updated as you suggested.

Rehabilitation and Return-to-Sport After Anterior Cruciate Ligament Injury and Reconstruction: Exploring Physical Therapists' Approaches in Argentina

Submission type: Original Research

Authors: *Eduardo Tondelli[1,2], Alejo Feroldi[2,3], Felipe García[2,4], Franco Meza[2,5], Bart Dingenen[6]*

Institutional Affiliations:

[1]Sport Physiotherapy, Faculty of Medical Sciences, Pontifical Catholic University of Argentina, Buenos Aires, Argentina

[2]Sport Physiotherapy (CPC), School of Physiotherapy, Faculty of Medical Sciences, University of Buenos Aires, Buenos Aires, Argentina

[3] Functional Anatomy and Biomechanics, Faculty of Medical Sciences, Favaloro University, Buenos Aires, Argentina

[4]New Performance Argentina Athletic Center, Buenos Aires, Argentina

[5]Physical Therapy and Medical Department, Club Atlético Huracán, Buenos Aires, Argentina

[6]Reval Rehabilitation Research Centre, Faculty of Rehabilitation Sciences, Hasselt University, Diepenbeek, Belgium

Corresponding Author:

Eduardo Tondelli

Buenos Aires

Argentina

E-mail: *eduardotondelli@uca.edu.ar*

Tel: +5491168994582